Geophysical Research Abstracts
Vol. 17, EGU2015-15549, 2015
EGU General Assembly 2015

Megathrust earthquake complexity from inversion of regional seismic waveforms: the Jan. 2011 Mw 7.1 Araucania, Chile earthquake

Stephen Hicks and Andreas Rietbrock
Liverpool Earth Observatory, University of Liverpool, Liverpool, United Kingdom (s.hicks@liverpool.ac.uk)

Recent and on-going analyses of the 2010 Mw 8.8 Maule, Chile earthquake, and subsequent postseismic processes, are dramatically improving our understanding of earthquake rupture processes along the subduction megathrust. Whilst the source processes of the Maule rupture have been studied in great detail, less is known about the rupture characteristics of moderate-strong aftershocks that followed. The study of large aftershocks may shed further light on mechanical heterogeneity along and around the subducting plate interface. The Maule earthquake was relatively devoid of large aftershocks; the largest aftershock was an Mw 7.4 event in the mainshock's immediate aftermath. Here, we study the second largest event of the aftershock sequence - the Mw 7.1 Araucania earthquake, that was located at the southern limit of the 2010 rupture area, and within the rupture area of the 1960 Mw 9.5 Valdivia earthquake.

For many large earthquakes, source complexity is investigated by inverting for slip on the rupture plane using various combinations of geodetic data and teleseismic waveforms. With the Araucania earthquake's offshore location, relatively moderate size and lack of near-field GPS data, regional seismic waveforms present the best opportunity to investigate source complexity.

We use the software package ISOLA-GUI (Sokos & Zahradník, 2008) to model the Araucania earthquake in terms of multiple point sources. Waveforms come from stations of the International Maule Aftershock Deployment (IMAD) that were still operating in early 2011. Strong motion instruments that were located close to the earthquake are vital for resolving source complexity. An ocean-bottom seismometer network in the region also provides important information on the location of both the rupture's nucleation point and its associated aftershocks.

Our single-source, low frequency solution is consistent with that of the Global Centroid-Moment Tensor (GCMT) solution, suggesting that overall, the Araucania earthquake was a plate interface thrust event. However, at higher frequencies, we find that waveforms are better explained by the presence of two discrete subevents. The first source (Mw 6.9), $\sim$8 s after rupture's nucleation, is located beneath the coastline and displays a thrust mechanism. Twelve seconds later, a second, slightly smaller asperity (Mw 6.8) ruptured with an extensional mechanism. Based on the second sub-event's normal faulting mechanism and the location of its aftershocks, we believe it ruptured along a steeper fault at the base of the marine forearc. It is therefore plausible that the initial rupture along the subducting plate interface immediately triggered the rupture of a fault in the overriding crust.

We discuss the characteristics of this triggered normal faulting event in terms of the geological structure of the overriding South American forearc. Such immediately triggered events will not seen by single point-source inversions in the far field. This source complexity has important implications for structural heterogeneity of the subduction megathrust and its associated seismic hazard.